MECHANICAL AND PHYSICAL PROPERTIES OF PLASTIC WASTE MIXTURE IN CONCRETE

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BACHELOR OF MECHANICAL ENGINEERING TECHNOLOGY (BMMV) WITH HONOURS

2022

Faculty of Mechanical and Manufacturing Engineering Technology

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A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical Engineering Technology (BMMV) with Honours

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this Choose an item. entitled "Mechanical And Physical Properties Of Plastic Waste Mixture In Concrete" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : 

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Date : 11 January 2023

APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (BMMV) with Honours.

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DEDICATION

I dedicate my dissertation work with a unique feeling of gratitude to my family and my friends, especially my mother, Intan Sapinat Binti Abdul Kadir. Thank you for love and support. Also give me some space to complete this thesis and project. Special thanks to my supervisor, Dr. Mohd Haizal Bin Mohd Husin, with his tremendous support and patiently given me guidance and teachings. Their words encourage and push for more persistence. I also dedicate this dissertation to my many friends who supported me throughout the process. I will consistently acknowledge all they have done. I am very thankful for these opportunities.

ABSTRACT

This thesis explains about mechanical and physical properties of plastic waste mixture in concrete. Dumping of plastic waste has become a serious issues as it is not properly handled. Reusing plastic waste, namely Polyethylene Terephthalate (PET), which is used as an aggregate in concrete component can reduce environmental pollution. Throughout this thesis, mixing method will be implemented where all the materials will be mixed together with various plastic waste mixture (PET) compositions in the concrete production. Besides, the effect of the influence of waste mixture (PET) in lightweight concrete based on the composition of waste mixture (PET) can be analysed after completed all the sample testing. In this research, preparation method played an important role for analysing physical and mechanical properties in terms of compressive strength, water absorption, density profile and moisture content. Different percentage of aggregate are selected in concrete mix design which are 1%, 3%, 5%, 6%, 8% and 10% composition of plastic waste mixture (PET). The process was started with raw material preparation and continue with preparation of PET aggregate into two sizes which are coarse and fine. The range size of coarse aggregate is 5 mm – 7 mm while for fine aggregate is 1 mm – 3 mm. In addition, there are five ratios of cement:sand being tested which are 1:1, 1:2, 1:3, 1:4 and 1:5 with total of 15 samples. Different ratios of samples are tested for compression test using Shimadzu Precision Universal Tester (Autograph AG-Xplus) to obtained the best ratio to be used as the benchmark sample of zero percentage of aggregate and to be proceed for sample fabrication. Concrete mix design is implemented with the ratio of 1:2 (cement:sand). During sample fabrication, all the prepared material are weighted according to the mix proportion and proceed with mixing process. The dry samples are then demoulded and ready to be tested for mechanical and physical properties such as compressive strength as well as water absorption, density profile and moisture content.

ABSTRAK

Tesis ini membincangkan tentang sifat mekanikal dan fizikal sisa plastik yang dicampur bersama konkrit. Lambakan sampah dari sisa plastik telah menjadi isu yang serius kerana tidak dikawal dengan betul. Dengan mengguna semula sisa plastik yang dikenali sebagai Polyethylene Terephthalate (PET) sebagai bahan campuran dalam konkrit, pencemaran alam sekitar dapat dikurangkan. Sepanjang tesis ini dijalankan, kaedah campuran telah digunakan iaitu dengan mencampurkan kesemua bahan sekaligus untuk membentuk satu komposisi baru menggunakan pelbagai amaun campuran sisa plastik dalam penghasilan konkrit. Selain itu, kesan yang mempengaruhi sisa campuran (PET) dalam konkrit ringan berdasarkan komposisi sisa campuran (PET) boleh dianalisis selepas pengujian sampel lengkap dijalankan. Dalam kajian ini, kaedah penyediaan sampel memainkan peranan penting untuk menganalisis sifat mekanikal dan fizikal dalam istilah kekuatan mampatan, penyerapan air, profil ketumpatan dan kandungan kelembapan. Peratusan berbeza untuk bahan PET telah ditetapkan dalam kajian ini. Antaranya ialah 1%, 3%, 5%, 6%, 8% dan 10% komposisi bahan sisa plastik PET. Proses dimulakan dengan penyediaan bahan mentah and diteruskan dengan penyediaan agregat PET kepada dua saiz iaitu kasar dan halus. Julat saiz untuk agregat kasar ialah 5 mm – 7 mm manakala untuk agregat halus pula ialah 1 mm – 3 mm. Sebagai tambahan, terdapat lima nisbah simen:pasir yang telah diuji iaitu 1:1, 1:2, 1:3, 1:4 dan 1:5 dengan jumlah 15 sampel. Nisbah yang berbeza telah diuji untuk ujian mampatan menggunakan mesin Shimadzu Precision Universal Tester (Autograph AG-Xplus). Ujian ini dijalankan untuk menentukan nisbah terbaik yang akan digunakan sebagai penanda aras bagi sampel yang tidak mengandungi agregat PET untuk diteruskan dengan proses penghasilan sampel. Kaedah campuran konkrit ini menggunakan nisbah 1:2 (Simen: Pasir). Sewaktu proses penghasilan sampel, kesemua bahan yang sudah disediakan telah ditimbang mengikut campuran perkadaran. Sampel yang telah kering dikeluarkan dari bekas acuan dan sedia diuji untuk mengetahui sifat mekanikal dan fizikal seperti kekuatan mampatan, penyerapan air, profil ketumpatan dan kandungan kelembapan.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my supervisor, Dr. Mohd Haizal Bin Mohd Husin for all his support, advice and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered. Besides, his timely and efficient contribution helped me shape this into its final form and I express my sincerest appreciation for his assistance in any way that I may have asked. Without his guidance, this project may not be completed within the time given.

Last but not least, from the bottom of my heart a gratitude to my beloved mother, Intan Sapinat Binti Abdul Kadir for her encouragements and who have been the pillar of strength in all my endeavors. My eternal love also to my siblings for their endless support, love and prayers. Finally, thank you to all my colleagues who had provided me the assistance, support and inspiration to embark on my study.

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LIST OF SYMBOLS AND ABBREVIATIONS

F	-	Force
A	-	Area
mm	-	millimetre
cm	-	centimeter
N	-	Newton
kN	-	kiloNewton
g	-	gram
%	-	Percent
MPa	-	MegaPascal

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Humans have relied on plastic as an inexpensive, adaptable, and durable material since the late twentieth century. PET, also known as polypropene, is a thermoplastic polymer used in a variety of applications such as food packaging, clothes, and building materials, and rit accounts for a significant portion of household garbage (Umasabor et al., 2020). PET is commonly used in the United States and is disposed after one usage. It is commonly utilized in the production of plastic bottles, food containers, and fabric fiber. PET stands for polyethylene terephthalate, which is a kind of polyester. It's frequently utilized in everyday things and is relatively easy to recycle. When stabilized, it takes on a semi-crystalline appearance. Because of its small weight, it is commonly used in rigid and flexible packaging. PET is one of those plastics that is used on a regular basis. PET is a fantastic choice for any application that requires a lightweight, impact-resistant material. PET is also one of the most widely recycled thermoplastics. Furthermore, ongoing attempts have been made to modify PET characteristics for greater performance with favorable cost profiles in order to meet high-end application demands.

As a result of plastic use, the buildup of plastic objects in the environment, such as plastic bottles and other items, has a negative impact on wildlife and their habitat, as well as humans. Plastic pollution is when a large amount of plastic is not recycled and ends up in landfills. Plastic garbage is thrown into unauthorized disposal sites in poor countries. The

majority of plastic garbage in less developed countries ends up in the ocean, putting marine species in particular at risk. Due to affordable yet durable, plastic usage increases among consumers. Plastic, on the other hand, degrades slowly due to its chemical nature, posing a significant difficulty. To solve the problem of plastic waste in the environment, plastic consumption must be reduced and raise knowledge about plastic recycling. The main issue with plastics is that many of them are extremely durable and can take hundreds of years to degrade. This is producing severe issues, such as the accumulation of plastic pollution on land and in the seas. Each year, between 1.15 and 2.41 million tonnes of plastic are projected to reach the ocean, accumulating in vast offshore zones (Alhazmi, H. et al., 2021).

Many types of plastic garbage can be reused or repurposed in various ways. This study focuses on repurposing plastic waste, namely Polyethylene Terephthalate (PET), which is used as a concrete component. Concrete is made up of fine sand and coarse aggregate joined together with a fluid cement that hardens over time. After water, which is the most widely used building material, concrete is the second most widely utilized substance on the planet. Plastic aggregate in concrete can be used in building applications since it has the same strength as ordinary concrete (Alhazmi, H. et al., 2021). Aggregate can have a smooth or a rough surface roughness. Although a smooth surface improves workability, a rougher surface creates a stronger bond between the paste and the aggregate, resulting in increased strength.

According to Almeshal, I. et al., (2020), the impact of using poly-ethylene terephthalate (PET) as a partial sand substitute in concrete was investigated. PET was used as a partial substitute for sand in a batch of six concrete compositions, with substitution amounts of 0%, 10%, 20%, 30%, 40%, and 50%. Concrete was cast to test the workability, unit weight, compressive strength, flexural strength, tensile strength, pulse velocity, and fire-

resistant behavior of fresh and hardened concrete. A variety of typical experimental tests were undertaken with various amounts of PET in the research report. Five different percentages of PET were employed in the mixes, as well as a control mix with no PET. This method helps to conserve natural resources such as sand while lowering the self-weight of concrete in constructions. Although raising the PET replacement ratio affected the mechanical qualities of concrete, plastic particles can be encapsulated from other components to generate ecologically friendly concrete. Furthermore, recycled PET bottles can be used in a variety of applications include constructions where strength is not a concern.

There are several test that can be conducted to test the compressive strength and water absorption in plastic waste (PET) mixture in concrete. Basically it were compressive strength test and water absorption test. Compressive strength is the major physical characteristic of the concrete which is the one that is most commonly applied in concrete brick design (Umasabor et al., 2020). Compressive strength refers to a material's or structure's ability to hold weights on its surface without cracking or collapsing under the load's pressure. Besides, the water absorption test analyses concrete surface water absorption rate (sorptivity). It is durability property that is related to concrete.

1.2 Problem Statement

The problem of dumping plastic waste is quiet critical due to its non-biodegradable nature and making it can last hundreds of years in the environment. Plastic can caused pollution when not handled properly but it is also has many advantages such as durability. Therefore, many plastic waste can be reused or used for different purposes. Since plastic waste becomes one of the primary factor lead to environmental pollution, it can be reused in the lightweight concrete in order to overcome the challenge facing by society today. The most effective ways for solving this problem are by implement reduce, reuse and recycle activity. By using plastic waste, as to reduce the amount of sand in lightweight concrete is actually save costs of production in the long run.

1.3 Research Objective

Specifically, the objectives are as follows:

a) To produce plastic waste mixture (PET) in concrete production by using mixing method which are mixing all materials with various plastic waste mixture (PET) compositions.

b) To explain the effect of the influence of waste mixture (PET) in lightweight concrete based on the composition of waste mixture (PET) and preparation method for physical and mechanical properties in terms of compressive strength, water absorption, density profile and moisture content.

1.4 Scope of Research

The scope of this research are as follows:

- Production of plastic waste mixture (PET) in concrete with various percentage which are 1%, 3%, 5%, 6%, 8% and 10% composition of plastic waste mixture (PET) by using mixing method.
- Samples of waste mixture (PET) in the concrete that has been produced will be tested for mechanical and physical properties such as durability and compressive strength as well as rate of water absorption, density profile and moisture content.
- Samples of waste mixture (PET) in the concrete that has been produced will be compared to the reference sample (0% of aggregate) in terms of mechanical and physical properties.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction to Plastic and Polymers

The importance of plastic and polymers in the evolution of civilization can be summarized in a few terms. Plastics are a specific type of polymer that has a wide range of usage as a raw material for the manufacture of many new gadgets. As a result, not all polymers may be classified as plastics. By combining of monomer units polymer is generated with a large range of chemical and physical properties. Its presence may be felt everywhere, from little domestic appliances to massive industrial machinery (Hassan, T. et al., 2022). Its advantages include lightweight, durability, chemical inertness (in most situations). It has variety of additional mechanical features including as strength per unit weight, scratch resistance and hardness. Without polymer and its product in a world, all of these factors have made it impossible to imagine. They also have a significant negative influence on the environment. As a result, plastics products with other biodegradable materials is not enough as it can also be recycled to the greatest extent possible. As a result, it is currently one of the most sought-after research subjects.

2.1.1 About plastics and polymers

Polymerization is a fundamental chemical reaction that involves joining monomer units (Ethylene, Propylene) in a chain or a complex network using a specific chemical reaction mechanism, primarily addition and condensation. The most commonly used polymers in our daily lives, polyethene and polypropylene, come from crude oil and natural gas refineries (Hassan, T. et al., 2022). The polymerization process isn't restricted to a narrow area. Polymers have existed from the beginning of the cosmos and life, and a variety of natural polymerization processes have occurred in our environment.

2.1.2 Characterization of traditional polymers

The available production technology and desirable material qualities caused synthetic polymers produced from fossil fuels played an important role in polymer science from its inception. As a result, modern polymers made from renewable resources have unable to totally substitute their function. The fossil (polyethylene), PP (polypropylene), PET (polyethylene terephthalate), PS (polystyrene), and PVC (polyvinyl chloride) are still dominant in our modern applications because they are light, cost-effective, and meet the design standards. PE and PP, for example, are crystalline at room temperature and may be moulded. PET, on the other hand, has a glass transition temperature much above room temperature, giving it greater toughness and dimensional stability. It is self-evident that suitable testing procedures are required for characterization of any material in order to forecast its physical and chemical properties, which is the primary requirement of engineering product design. Today, various physical and chemical polymer testing methods are available, with many more in the research stage. (Hassan, T. et al., 2022). As the usage of recycled plastics has become more widely promoted as a means of achieving sustainable

development, its characterization has become a key consideration in product design. For example, after being separated from undesired foreign particles, homogenized, and heat treated to give it uniform mechanical qualities, PET scrap appears to be recyclable. For a thorough mechanical analysis, its tensile characteristics, dynamic viscosity, and thermo-oxidative stability are investigated.